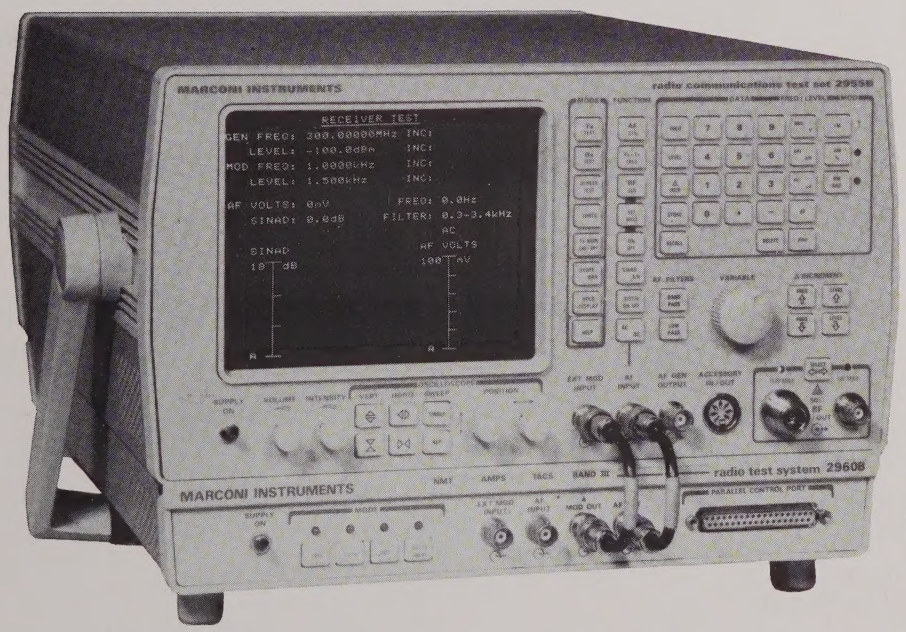
Marconi
Instruments

RADIO TEST SYSTEMS

2960 and 2960B



Programming Manual

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Programming Manual

H 52960-900R
Vol. 1A

RADIO TEST SYSTEMS

2960 and 2960B

Multi-system Capability

2960 Part no. 52960-900R (with 2955)
52960-910U (with 2955A)
52960-321Z (with 2955R)
2960B Part no. 52960-500Y (with 2955B)

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ASSOCIATED PUBLICATIONS

Programming Manual Supplements	(See the Preface.)
Operating Manual	Part no. 46881-900L
Operating Manual Supplements	(See the Operating Manual.)
Service Manual, 2960 Adapter	Part no. 46881-911T
Service Manual, 2955A and 2955R	Part no. 46881-954A

PREFACE

The Radio Test Systems 2960 and 2960B consist of a Radio Communications Test Set 2955 series with a Multi-system Adapter. The Adapter includes software for one or more systems. The Adapter can accept up to six co-resident options. Four options are currently available as below.

Features which are common to all of the systems are described in this Programming Manual.

To describe features in which there are differences between systems, there is a Programming Manual Supplement for each system. The Supplement has the same number as the Option as follows:-

Option no.	System	Supplement	
		No.	Part no.
10	NMT	10	46881-931N
20	AMPS	20	46881-932L
30	TACS	30	46881-933J
50	Band III	50	46881-935G

Throughout this Manual, references to the 2960 also apply to the 2960B.

AMENDMENT STATUS

Each page bears the date of the original issue or the date and number of the latest amendment. Any changes subsequent to the latest amendment are included on Manual Change sheets coded C1, C2 etc.

WARNINGS AND CAUTIONS

See the Operating Manual.

Chapter 1

INTRODUCTION TO PROGRAMMING

PURPOSES OF PROGRAMMING

The programming capability of the 2960 can be used for two distinct applications as follows:-

(a) To operate the 2960 from a remote position. The test sequences and test routines can be those which are built-in or they can be defined by the user.

(b) To execute programs which have been written by the user.

In these programs, the user can define the following:-

(a) Test sequences - sequences of built-in and/or user-defined test routines.

(b) Test routines - routines as the built-in ones but with parameters changed.

(c) Screen displays.

(d) Printout formats.

The user's programs are retained in non-volatile memory and can be stored on and loaded from floppy discs.

METHODS OF REMOTE CONTROL

All the key-type controls on the 2960 function in the same way as a computer keyboard. When a key is pressed, the key's code is sent to the internal microprocessor. It follows that the keys' codes can be generated externally.

Similarly, as the 2960's screen display is generated by the internal microprocessor, it follows that the display data can be passed to a printer.

As shown in Fig. 1-1, the three ways to remotely control an instrument are as follows:-

(a) From a GPIB controller, through a GPIB to the instrument's GPIB port.

(b) From a microcomputer which is fitted with a GPIB interface unit, through a GPIB to the instrument's GPIB port.

(c) From a microcomputer which is fitted with an RS-232 interface unit, through an RS-232 link to the instrument's serial port.

The GPIB system is suitable for connecting up to fifteen instruments on a maximum total bus length of 20 m. The maximum baud rate is 1 Mbits/s.

The RS-232 system is suitable for a direct link on a maximum length of 15 m. Modems can be inserted to use a telephone line or any other asynchronous system. The maximum baud rate is 9.6 kbits/s.

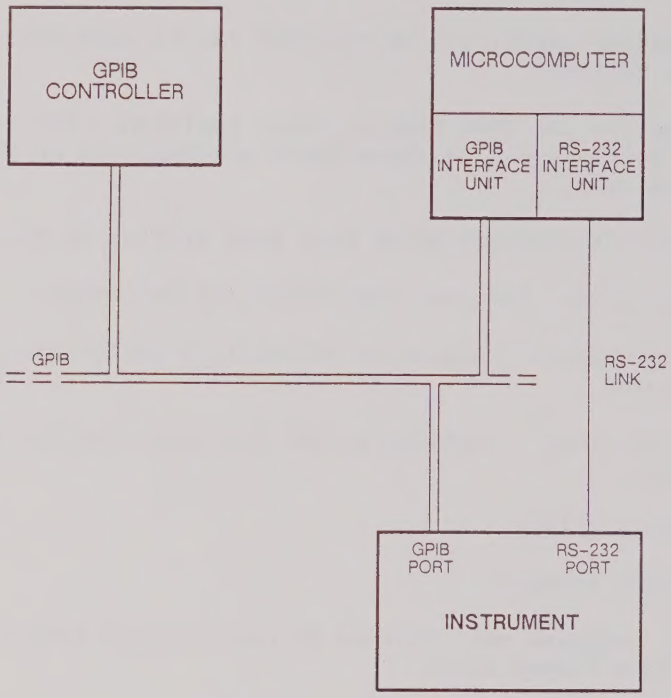

Fig. 1-1 Methods of remote control

RS-232 INTERFACE UNIT

When the unit has appropriate switches, it is necessary to set them to the COM port number and the IRQ number.

It is necessary to program the RS-232 interface for the required baud rate, parity, data bits and stop bits. This can be done under MS-DOS or in BASIC.

Port setting under MS-DOS

Enter the asynchronous communications mode as follows:-

MODE COM<m>:<baud>[,<parity>[,<databits>[,<stopbits>]]]

where m = COM port number,
baud = 110, 150, 300, 600, 1200, 2400, 4800 or 9600,
parity = N (none, O (odd) or E (even),
databits = 7 or 8,
stopbits = 1 or 2.

Port setting in BASIC

Open the communications channel as follows:-

```
OPEN "COM<m>:<baud>[,<parity>[,<databits>[,<stopbits>]]]"

where m        = COM port number,
      baud     = 110, 150, 300, 600, 1200, 2400, 4800 or 9600,
      parity   = N (none, O (odd) or E (even),
      databits = 7 or 8,
      stopbits = 1 or 2.
```

Setting the 2960

Using the INTERFACE MENU, it is necessary to set the instrument for the required baud rate, parity, data bits and stop bits.

GPIB PROGRAMMING

For a GPIB controller, the appropriate commands are detailed in the appropriate Programming Manual Supplement.

For a microcomputer which has a GPIB interface unit, the same commands can be entered in a TBASIC program.

RS-232 PROGRAMMING IN BASIC

An instrument is controlled remotely by sending the appropriate commands to it. These are ASCII strings and are detailed in the appropriate Programming Manual Supplement. The commands are sent to the instrument by entering them as constants in a BASIC program. When the BASIC program has been entered, then it can be RUN.

PROGRAMMING MODES

There are three of these as follows:-

(a) Immediate mode. WAITING FOR RUN is displayed on the screen.

(b) Learn mode. IN LEARN MODE is displayed on the screen.

(c) User mode. IN USER MODE is displayed on the screen.

In immediate mode, the 2960 responds to each individual command as it is received.

In learn mode, the 2960 retains program statements for a user-defined test sequence.

In user mode, the 2960 retains program statements for a user-defined test subroutine.

Chapter 2

WRITING A PROGRAM

INTRODUCTION

In the remote CRTS immediate mode, the 2960 is controlled by means of commands on the GPIB or through the RS-232 port.

In the remote pass-through mode, the 2955 is controlled by means of commands on the GPIB or through the RS-232 port.

In the remote CRTS learn mode, the 2960 is controlled by means of statements in a program.

Each command or program statement consists of a command code, numerical data as appropriate, ASCII strings as appropriate and suitable delimiters. For convenience, spaces can be included between command codes and data but not within data. The syntax of commands and program statements is in seven forms. Full details of syntax forms are given on pages 2-2 to 2-4.

Command codes are mnemonics of English words and abbreviated English words. They can be entered as upper or lower case letters - the 2960 does not differentiate. To reduce the number of bytes used to store a program, most command codes are tokenized. Each token is a single byte above 7F hexadecimal (i.e. above the ASCII range). Full details of command codes are given in the Programming Manual Supplements.

Programming also allows the user to define his own parameters in test routines. Further information on this subject is given on pages 2-4 to 2-6.

Programming allows the user to define his own test sequences. Further information on this subject is given on pages 2-6 to 2-8.

Error messages are detailed on page 2-9.

All ASCII strings have to be enclosed within single or double quotation marks except for the string following COMMAND. After COMMAND, the string is not enclosed in quotation marks unless they are also intended to be sent to the 2955.

SYNTAX

Conventions

The following are used in this manual:-

Notation	Explanation	Example
AAAAAAAA	Items which are entered as a string	END
AAAAaaaa	Minimum abbreviation in upper case and optional characters in lower case	SAve
<AAAAAA>	ASCII control code or keyboard function to be entered as a single key stroke	<SPACE>
<aaaaaa>	Information as described which is to be entered as a string	<integer>
<"aaaa">	Information as described which is to be entered as a string within quotation marks	<"text">
[ ]	Entry of the enclosed item is optional	[<LF>]
{ | }	The enclosed two (or more) items are alternatives	{<,>|<LF>}
...	The previous type of entry can be repeated as necessary	<integer> <,> ...

Delimiters

Every statement has to end with a delimiter or with another command code. There are three types of delimiter as follows:-

(1) High priority. Used to terminate command statements.

<LF> for linefeed, <ETX> for end of text or <ETB> for end of text block.

Where a high priority delimiter <LF> is shown, <ETX> or <ETB> can be used instead.

(2) Low priority. Used to give delimiting without a linefeed. Also used for the separation of separate fields within a command statement.

<,>, <SPACE>, <;> or <CR>.

Where a low priority delimiter <,> is shown, <SPACE>, <;> or <CR> can be used instead.

(3) Text. Single or double quotation marks for ASCII literal strings.

Syntax forms

There are seven forms of syntax as follows:-

(1) <command code> {<,>|<LF>}

Example: DEFAULT<,> (Set default parameters.)

(2) <command code> [<,>] <integer> {<,>|<LF>}

Example: TEST 28<LF> (Execute test routine no. 28.)

(3) <command code> [<,>] <integer> <,> ... <value> <,> ... <LF>

This syntax form has compulsory delimiters for separting adjacent numbers. There can be any number of separate integers and values.

Example: PARAMETER9,2,30W,5W<LF> (Set DC power parameters at 30 W and 5 W.)

(4) <command code> [<,>] [<integer> <,> <integer>] <,>
{<command code>|<"text">} {<,>|<LF>}

This syntax form applies to PRINT and WRITE only. There are two types of statement - one prints or displays immediately; the other does so at a defined set of co-ordinates. When the latter is required, the co-ordinates are entered as the two integers separated by a low priority delimiter. Then, there is another command code (e.g. ESN for the equipment serial number to be printed or displayed) or text.

Examples: (1) PRINT SEQTTL<,> (Print the current test sequence title.)

(2) WRITE 3,9,"WARNING"<LF> (Write WARNING at column 3, row 9.)

(5) <command code> [<,>] <integer> <,> <integer> {<,>|<LF>}

This form has two integers separated by a compulsory delimiter.

Example: JBC7,66 (Jump to LABEL 66 if bit 7 is clear.)

(6) <command code> <,> "text" <LF>

Example: SEQTTL "QUICK TEST"<LF> (Title of test sequence is QUICK TEST.)

(7) <COMMAND> [<,>] <statement> ... <LF>

This is only used with COMMAND. It causes the statement(s) between COMMAND and the high priority delimiter to be passed through to the 2955.

Example: COMMAND RGFR850.015MZ<LF> (Generated RF to be 850.015 MHz.)

Notes...

(1) Most statements can be concatenated into one data stream by using commas or spaces as delimiters. However, some of them require a terminating linefeed.

(2) All numbers have to be in decimal format unless otherwise stated.

(3) The maximum length of a string is 40 characters.

(4) In serial control mode, the 2960 inserts a linefeed whenever a carriage return is encountered.

COMMAND CODES

As there are slight differences between systems, the command codes are detailed in the Programming Manual Supplements.

Settings are retained in non-volatile memory until a new system option is selected except for CSL and SRQ. When a new system is selected, the default settings apply. CSL and SRQ settings are not retained but revert to 0 when the instrument is switched on.

TEST ROUTINE PARAMETERS

Guidance on changing the parameters of the test routines is given below. In the Programming Manual Supplements, details are given of the possible range and the default value of each parameter for each test routine.

For each test routine, there are from one to five parameters as described below.

Parameter 1

This controls, as appropriate, the following:-

(a) The type of test result required.

(b) Cellular radio or private mobile radio (PMR).

(c) Type of measurement - Distortion, SINAD, S/N or residual noise. In test routines no. 3 and no. 6, SINAD (Distortion) is a special case in which SINAD is measured but DISTORTION is shown on the screen.

(d) Type of filter - 15 kHz LP, 0.3 to 3.4 kHz, 300 Hz LP or psophometric.

(e) Setting of control port lines.

(f) RF power level settings.

(g) Actions at handoff.

(h) SAT transponding, deviation and frequency.

These are all controlled by 0 or 1 states of bits in a byte. The resulting binary number is converted to a decimal number for entry in a program.

The type of test result can be expressed in different ways as follows:-

(a) Reference value and maximum error (RV & ME). This is a reference value (RV) together with a maximum permissible error (ME) (i.e. the maximum ± difference from the RV). The RV and ME, UL or LL are set under parameters 2 and 3. The RV can be the current channel frequency (RV & ME (CC)).

(b) Upper limit and lower limit (UL & LL). These are the limits of the range in which the reading is to be.

Examples: (1) If it is required to test transmitter power (test routine no. 1) using upper and lower limits, bit 0 has to be set to a binary number of 00000001. Accordingly, the decimal value 1 is entered as parameter 1 for test routine no. 1.

(2) If it is required to test transmitter AF residual noise (test routine no. 3) using a 300 Hz low pass filter, bits 4 and 5 have to be set for the residual noise measurement to a binary number of 00110000 (decimal 48) and bit 3 has to be set for the filter to a binary number of 00001000 (decimal 8). Adding these together gives a binary number of 00111000 (decimal 56). Therefore, the decimal number 56 is entered as parameter 1 for test routine no. 3.

Parameter 2

This controls, depending on the test routine and the type of result which has been selected, one of the following:-

(a) Reference value and unit (RV).

(b) Value and unit for the upper limit (UL).

(c) Value and unit for the lower limit (LL).

Parameter 3

This controls, depending on the test routine and the type of result which has been selected, one of the following:-

(a) Value and unit for the maximum permissible error (ME).

(b) Value and unit for the lower limit (LL).

(c) Value used in special tests.

Notes...

(1) RV & ME. Providing the ME is in the same units as the RV, the created range for RV ± ME is checked against the given range (e.g. if 900 MHz is entered as the RV and 150 MHz is entered as the ME, the range created is 750 to 1050 MHz. As the given range is 0 to 1000 MHz, a parameter range error is indicated).

(2) UL & LL. Parameters 2 and 3 have to be in the same units.

Parameter 4

Except in test routine no. 28, this controls the nominal modulation level and complies with the ranges 100 Hz to 25 kHz, 1 to 70% and 0.1 to 10 rads.

In test routine no. 28 only, this controls the value and unit of the upper limit (UL) of particular power levels.

Parameters 4 and 5

In test routine no. 28 only, this controls the value and unit of the lower limit (LL) of particulat power levels.

Changing the parameters

Parameters are changed by means of a statement in a program. This consists of PARameter, the test routine number, the first parameter to be changed and the data for this and each subsequent parameter.

Example: PARAMETER 6,1,28,26dB,-80dBm, 2kHz<LF>

This begins (PARAMETER6) by specifying test routine no. 6 and then (1), parameter 1 is specified. The value and unit of parameters 1, 2, 3 and 4 (28, 26dB, -80dBm, 2kHz) are stated. This means a receiver SINAD measurement with the psophometric filter (16 + 12 = 28) with a lower limit of 26 dB and a reference modulation level of 2 kHz.

Note...

The number of the first parameter is always given so that a shortened form can be used starting with parameter 2, 3 or 4.

USER-DEFINED TEST SEQUENCES

Guidance on entering your program is given below. Sample programs are given in the Programming Manual Supplements. Also, the programs for the built-in test sequences are given so that these can be used as the basis for your own programs.

Entering a program

Enter your program as follows:-

(1) Connect the programming device to either the GPIB port or the RS-232 port.

(2) After switch-on, press the CRTS key to enter local CRTS mode. Wait until initializing and self-testing have finished.

(3) Send the appropriate remote command from the programming device. Using a GPIB controller with a 2960 which has been set to GPIB address 06, send REMOTE 706. For RS-232 operation, send <CR>.

(4) The 2960 enters the FULL AUTO TEST mode and displays WAITING FOR RUN. For RS-232 operation, it is useful to send ECHO 1 so that each character is echoed back to the terminal.

(5) Allocate a title to the user-defined test sequence. Send SEQTTL followed by, enclosed in quotation marks, the title of up to 22 characters.

(6) Send LEARN to enter the learn mode. WAITING FOR RUN is replaced by IN LEARN MODE.

(7) Now, enter the main body of your program. Guidance on writing this is given below.

(8) Terminate the program by sending END. The user-defined test sequence is now in memory. WAITING FOR RUN is redisplayed.

(9) To select the user-defined test sequence, send TSI4. Using a typical GPIB controller, send OUTPUT 706;"TSI 4". This causes the display to change to the user-defined test sequence.

(10) Prior to running the program, it is worth saving the program on disc in case it is later overwritten. If this happens, the program does not then need to be re-entered but merely reloaded from disc. The displayed starting parameters should be correctly set up before saving since both the user-defined program area and the non-volatile variables are recovered with the disc file.

(11) To run the user-defined test sequence, send RUN. This is equivalent to START TEST in 2955 local mode.

(12) The user-defined test sequence is now executed. If there is an error in the program, an ERROR message is displayed. See 'Error messages' on page 3-2-40. The error has to be corrected and the program reloaded before re-running. For a non-recoverable error (e.g. the program in a continuous loop), it is necessary to switch off and start again. If required during a run, the test sequence can be aborted by sending the ESCape character CHR$(27).

Program construction

A modular programming technique should be used. In this, the main routine is used as follows to display the title of the test sequence, request operator interaction and display the measurement results.

Subroutines are used to perform the actual measurements or other actions. This allows the main routine to be defined without regard to the details of making the measurements etc. It also allows each subroutine to be changed without affecting either the main routine or the other subroutines.

To pass program flow from the main routine to a subroutine, GOSUB is used. To return to the main routine, RETURN is used. Subroutines can be nested to a depth of six levels. When this number is exceeded, a warning message is given. Each subroutine is identified by its LABEL which is uniquely numbered.

The default parameters for the built-in test routines (i.e. following DEFAULT) can be modified in user-defined test sequences.

Example: WRITE 3,29 SEQTTL GOSUB 60 WRITE 23,29,RESULT JUMP 61 <CR><LF>
LABEL 60 TEST 21 RETURN <CR><LF>
LABEL 61 END <CR><LF>

This begins (WRITE 3,29 SEQTTL) by writing the previously allocated title of the test sequence on the screen at column 3, row 29. It then goes (GOSUB 60) to the subroutine which is identified by LABEL 60. This subroutine (TEST 21) causes test routine no. 21 (call placement from to mobile) to be performed. After this, program flow is returned to the main routine (WRITE 23,29,RESULT). The result is written on the screen at column 23, row 29. Finally, the program makes an unconditional jump (JUMP 61) to LABEL 61. This terminates the program.

Notes...

(1) In the example, the screen row which was chosen is far enough down the screen not to intrude on the normal test display area.

(2) In the example, the three program lines could have been run together but, due to the restriction of the 80 character buffer, it is better practice to use high priority delimiters between quite small sections of program.

(3) In the example, the JUMP 61 was used in the program in order to jump around the subroutine to the END command.

(4) It is recommended that, following an unattended initializing and self-testing, RD56 is sent to read any calibration error code and, after a disc operation, RD57 is sent to read any disc error code.

ERROR MESSAGES

The following messages are displayed when errors are found in user-defined test sequences:-

Error message	Meaning
ERROR: PARAMETERS FLAG	Illegal bit combination in parameter 1.
ERROR: xxxxxxxx FILTER	Illegal filter bits in parameter 1.
ERROR: PARAMETERS UNITS	Invalid units for one or more parameters.
ERROR: PARAMETERS RANGE	Parameters outside permitted range.
ERROR: NOT IMPLEMENTED	Test routines no. 10 to no. 19 not yet in use.
ERROR: ZERO REFERENCE	For a reference and maximum error type result, the reference cannot be zero unless the maximum error is in the same units as the reference.
ERROR: NO DC POWER	Avoids wasting time re-testing if failed already.

If a parameter is too large or too small, an acceptable value is shown with a > sign or a < sign (e.g. >9.99 or <0.01). This can also show when the user has not understood the syntax of parameter since the display shows the 2960's interpretation of the parameters.

During the DC power test, the DC voltage and current are also shown. The parameters and DC readings are only shown when the display format is FULL. When the display format is SUMMARY, only the single line giving the test routine title, status and result is displayed.

When the type of test result in parameter 1 is the reference value and the maximum error (RME), the 2960 checks that the maximum error is in units which are compatible with the reference units for purposes of calculation. Compatible units, together with whether the result is a ratio (R) or a difference (D), are as follows:-

Maximum error unit	Reference unit												
	None	V	Hz	A	W	s	dB	dBm	dBV	dBW	rad	ppm	%
None	D	-	-	-	-	-	-	-	-	-	-	-	-
V	-	D	-	-	-	-	-	-	-	-	-	-	-
Hz	-	-	D	-	-	-	-	-	-	-	-	-	-
A	-	-	-	D	-	-	-	-	-	-	-	-	-
W	-	-	-	-	D	-	-	-	-	-	-	-	-
s	-	-	-	-	-	D	-	-	-	-	-	-	-
dB	-	R	-	R	R	-	D	D	D	D	-	-	-
rad	-	-	-	-	-	-	-	-	-	-	D	-	-
ppm	R	R	R	R	R	R	-	-	-	-	R	D	-
%	R	R	R	R	R	R	-	-	-	-	R	-	D

Transmitter RF distortion and transmitter modulation limiting test routines attempt to set the transmitter carrier to a reference modulation level deviation by varying the AF generator output. NO MODULATION or READING UNSTABLE is shown when the 2960 is unable to set the reference modulation level.

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